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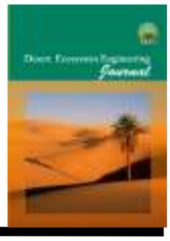

Investigating the spatial variations of drought indices and their effect on soil salinity in Yazd-Ardakan Plain

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Extended Abstract

Introduction: Drought is an atmospheric phenomenon that affects different components of the environment. Caused mainly by the lack of precipitation, It is considered as the most dangerous natural phenomenon. All regions of the world may occasionally be affected by droughts, but it is more common in areas that are climatically and accidentally influenced by different climatic systems. Although groundwater resources are normally affected by drought, they are not much accounted for in relevant studies. Delayed meteorological droughts in one place could lead to hydrological droughts that are caused by stress to water resources. Groundwater resources are among the environmental phenomena which are highly affected by drought. In the last decade, numerous studies have been conducted on meteorological and groundwater droughts, indicating a significant relationship between meteorological and hydrogeological drought indices. In arid and semi-arid regions, reduction of the level of the groundwater table water and degradation of its chemical quality (due to increased solute concentration) play a key role in causing secondary soil salinity, surface water salinity, soil fertility decline, etc. Considering the importance of meteorological and groundwater droughts in recent decades and their impact on the salinity of Yazd Ardakan plain and consequently the vegetation of the region, the present research is a prospective study that uses data mining methods for salinity modeling. It was conducted over an 18-year common statistical period (1998-2016). So far, the relationship between drought and soil salinity has not been investigated in this plain.

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Materials and methods: The study area was Yazd-Ardakan plain. Having an area of 15950.70 km, Yazd-Ardakan plain is located in the northern part of Yazd province and covers roughly 24.9% of the total area of the province. The average precipitation at many intersections of the plain is less than 65 mm per year. Yazd-Ardakan plain includes vast cities such as Mehriz, Yazd, Ashkezar, Meybod, and Ardakan. The plain is bounded on the west and southwest by Shirkouh Mountains, and on the east by Kharnaq Mountains. To perform this study, precipitation data were first collected from the relevant database of the Weather Meteorological Organization. Moreover, the groundwater data were gathered from 38 wells which were located in the area which belongs to the Organization of Regional water of Yazd. Having carefully examined the data regarding 18 years of precipitation in the region (1376-1394), it was considered as a common statistical period for all the stations from which the required data were obtained. Standard Precipitation Index (SPI) and the Groundwater Resource Index (GRI) were used to assess the meteorological drought in the region. Salinity data were also obtained from 84 sites of Yazd-Ardakan plain in 2014 from the Soil Database of the region. Then, the weighted distance interpolation method was used to map drought severity in the ArcGIS software. Satellite images were also used to extract the auxiliary parameters. Landsat 7 and 8 satellite bands for the summers of 2006, 2010, 2014 (bands 1 to 5, and bands 7) were downloaded from the USGS site. This study sought to investigate the temporal and spatial variations of drought and their effect on soil salinity in Yazd – Ardakan plain. The vegetation index (NDVI) was also obtained, using the aforementioned images. Then, using the artificial neural network to find the relationship between the soil salinity parameter in 2014 and the environmental variables (satellite image data, SPI and GRI drought indices, vegetation index, and digital elevation model), the soil salinity was determined for the study area. Moreover, soil salinity maps were prepared for the years 2006, 2010, and 2014. To model the salinity, the optimal structure of the network was determined after the initial preprocessing of raw data.

Results: Having studied the SPI and GRI zoning maps of the year 2006, the highest drought rates were found in both the central and southern plains. The mean SPI index was 0.08 and the GRI index was 0.21. In terms of the SPI index, drought was almost normal and the GRI status was mild. In 2010, the highest meteorological drought in the eastern part of the Yazd Ardakan plain was reported as being -0.04, indicating an almost normal type of drought this year. The average Groundwater index in the central, eastern, and northwestern parts of the plain was 0.49, which is considered as a mild groundwater drought. In 2014, the highest meteorological drought was observed in the northern and southern parts of the plain, and the highest rate for the groundwater index was found in the northern part of the basin. The average SPI and the GRI indices for the same year were 0.07 and 0.52 respectively, which are considered as normal drought for the plain. The vegetation index map showed the average vegetation index to be 0.28, 0.30, and 0.29 for 2006, 2010, and 2014 respectively. Soil electrical conductivity in 2014 varied from 35 to 197.30 dS/m and its coefficient of variation was 121.2%, indicating a high variability of salinity in the study area. The model successfully predicted the salinity value with acceptable accuracy. Consequently, salinity values for 2010 and 2006 were predicted, using the neural network model. The average salinity of the region was 56.17, 58.73, 59.48 dS/m in 2006, 2010, and 2014 respectively, suggesting an increasing trend in soil salinity.

Discussion and Conclusion: The results showed that the average salinity in the area had been increasing over the three years studied, reaching an average of 56.57 dS/m in 2006 and 59.58 dS/m in 2014. Most of the soil salinity in 2014 was found in the northeast and east of the basin, and parts of the center were saline from the north to the south. The results also indicated that the neural network method could well predict salinity values in previous years, using input variables such as satellite imagery, digital elevation model, meteorological and groundwater drought indices, and vegetation index. As found by the correlation reports, it could be concluded that the salinity increased in the area with increasing severity of meteorological drought and consequently increasing groundwater drought and decreasing vegetation.

Keywords: Meteorological drought, GRI, Neural network, Soil salinity.

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